Title: Simulations Using the Random Number Table

Brief Overview:

The unit will introduce the Random Number Table for performing simulations in Probability. Each simulation will follow the five (5) steps of: stating the problem, stating the assumptions, assigning the digits, simulating the experiment, and stating the conclusions. Emphasis is placed on using the procedure, using the Random Number Table to simulate the experiment, and presenting the results.

Links to NCTM 2000 Standards:

- **Mathematics as Problem Solving, Reasoning and Proof, Communication, Connections, and Representation**
  These five process standards are threads that integrate throughout the unit, although they may not be specifically addressed in the unit. They emphasize the need to help students develop the processes that are the major means for doing mathematics, thinking about mathematics, understanding mathematics, and communicating mathematics.

  Students will apply the steps to develop the simulations using the Random Number Table to understand both the procedure and the table and to adapt the strategy learned to new situations. They will use inductive reasoning to observe the data, analyze the results, and make comparisons and generalizations from their observations. Students also will use written and oral skills to share the results of their simulations and their analyses. They will be able to compare and connect their simulated results with the theoretical results obtained by tree diagrams and/or a formula. Last of all, students will create and use representations to organize, record, and communicate mathematical ideas. They will use representations to model and interpret physical, social, and mathematical phenomena.

- **Data Analysis, Statistics, and Probability**
  Students will collect, organize, and interpret data using the methods of exploratory data analysis; and will understand and apply the basic notions of probability and average.

Links to Virginia High School Mathematics Core Learning Units:

- **Algebra I (A.18)**
  Students will compare multiple one-variable data sets using statistical techniques.

- **Algebra II (AII.19)**
  Students will collect and analyze data to make predictions and solve problems.

Grade/Level:

Grades 9-12; Algebra I, Algebra II, Statistics, Discrete Mathematics, AP Statistics

Duration/Length:

The complete learning unit will take approximately three to five 50 minute classes that will include two days for the actual simulations.

Prerequisite Knowledge:

Students should have a working knowledge of the following skills:

- Basic formula for Probability of an event
- Fairness or unbiased concept
- Tree diagrams
- Randomness

Objectives:

Students will be able to:

- perform a simulation in the five-step procedure.
- demonstrate the appropriate use of the Random Number Table in order to complete the simulations.
- analyze the data and interpret the results.
- communicate their results both in writing and orally.

Materials/Resources/Printed Materials:

- Simulation Worksheets
- Four coins
- Graphing calculator

Development/Procedures:

The class will be divided into groups of two or three. With four coins and the Simulation #1 worksheet, each group will follow the steps on the worksheet carefully to understand the procedure and how to read the Random Number Table. The teacher will rotate about the room and facilitate as necessary. All questions on the procedure and the table need to be addressed before proceeding to the next simulations. The groups will write the results and generalizations on the worksheet and present the findings to the rest of the class. After successfully completing Simulation #1, the groups will proceed to Simulations #2 and #3.

Assessment:

Group evaluation will be based on the data derived from the Random Number Table, correct analysis and interruption of data results, and accuracy of the tree diagrams.

Extension/Follow Up:

- The groups could create additional simulations to practice both the procedure and the use of the Random Number Table.
- Different Random Number Tables can be used from any textbook using probability such as The Practice of Statistics by Daniel Yates, David Moore, and George McCabe.
- Random integers can also be generated from any graphing calculator with a Random function feature such as the TI-83. Instructions for the random number feature for the TI-83 can be found in the manual, Exploration Statistics Handbook for the TI-83 by Larry Morgan and TI-83 Graphing Calculator Guidebook by Texas Instruments.
- Random tables also can be generated from statistical computer software, Minitab.

Author:

Dr. Margaret U. Paprocki
West Springfield High School
Fairfax County, VA

SIMULATION #1

Using Random Number Table

Name:_____

Date:_____Period:_____

Each group will perform the following steps for the simulation.

1. State problem or describe experiment
2. State all assumptions
3. Assign digits to represent the outcomes
4. Simulate the repetitions
5. State the conclusions in complete sentences

This simulation has steps 1, 2, and 3 already completed to illustrate the procedure.

Problem: What is the probability for finding **2 heads and 2 tails** if you toss four coins? Do 25 trials to estimate the probability.

Assumptions: The probability of heads or tails is equally likely to occur on each toss. The tosses are independent of each other.

Assign digits: In a Random Number Table with digits 0,1,2,3,4,5,6,7,8,9, assign the heads to all even numbers and the tails to all odd numbers. Zero is considered even.

Simulation: Look at the Random Number Table and pick a beginning point. Read the numbers horizontally across the row in the table. Follow the line **consecutively** as you assign heads or tails to each digit. An example is shown below that starts at the upper left hand corner of the given table. The results are recorded in the table below.

8501|3	810|**10**	**05**|520
HTHT|T	HTH|**TH**	**HT**|THH

TRIAL	RESULT	2 HEADS AND 2 TAILS?
1	HTHT	YES
2	THTH	YES
3	THHT	YES

SIMULATION #1

Using Random Number Table

For simplicity and accuracy, read the table horizontally and continue each trial with the next consecutive digit in the line. **DO NOT** start over at the beginning of each line or move over to another section.

a. Continue the simulation started below until 25 trials are complete. Record your results in the table that follows:

TRIAL	RESULT	2 HEADS AND 2 TAILS?
1	HTHT	YES
2	THTH	YES
3	THHT	YES
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

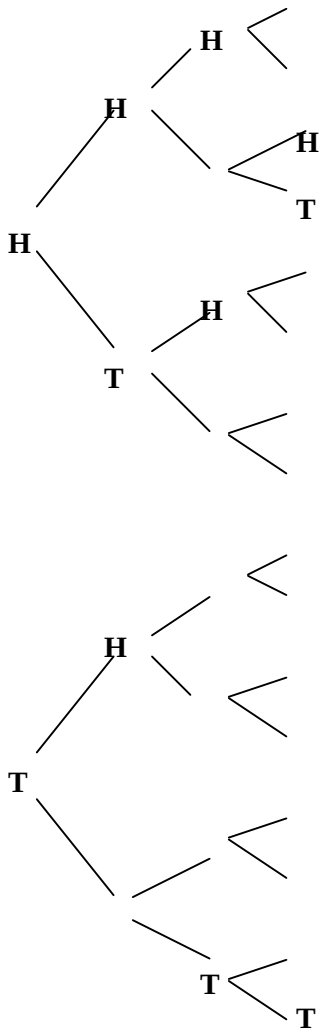
b. Count the number of successes in obtaining **2 heads and 2 tails**:_____

SIMULATION #1

Using Random Number Table

c. Calculate the probability by using the formula: $p = \frac{successes}{trials}$ = _____

d. Complete the tree diagram to find the theoretical probability:



***P*=_____**

SIMULATION #1

Using Random Number Table

Conclusions: State your conclusions in complete sentences.

_____

_____

RANDOM NUMBER TABLE

85013	81010	05520	94722	54751	94397	80273	11312	59476	73557
97831	38730	83800	60543	14636	48736	47033	44909	53102	95726
97676	89301	40643	44176	07438	22748	70318	26640	00018	65129
35454	46858	22215	15559	18946	54279	43079	88549	54321	74261
33808	77394	53672	16900	72283	69420	77584	89712	51987	65870
08818	73110	02546	72800	45870	17288	20941	00880	09507	41497
86996	47792	13423	91627	26728	22281	31489	37269	93842	51720
12235	00669	92756	07053	29520	62184	96619	96594	24286	94414
03803	79919	11684	38022	13198	32879	51408	87162	62871	77776
23832	43812	69919	77207	23136	37553	92164	08868	16340	14223
50173	29502	74381	73132	04020	57702	11826	29648	04555	22356
94743	20291	59698	77626	43134	44563	26094	80363	81505	93004
10564	36408	40529	16040	53555	21751	98507	99499	01145	04748
26116	38250	78762	80130	28123	78936	27675	37602	89478	60417
74263	65333	97032	86204	34202	46019	35942	41598	18280	35421
19358	79569	77310	97698	96740	41799	20622	03280	91432	39257
99900	62121	87653	43117	76954	26345	84095	22352	20035	90848
3599	64479	16130	22708	44230	15223	96619	60261	15404	36590
59079	15340	68215	15495	34639	45453	43673	77320	87704	86950
67597	64905	04640	43874	78429	18306	28540	69861	23540	34778

SIMULATION #2

Using the Random Number Table

Name:_____

Date:_____Period:_____

Problem: A newly wedded couple wants to have 5 children. They want **3 boys and 2 girls** in any order. What is the probability that they will get this combination? Do 30 trials to estimate the probability.

Assumptions:

Assign digits:

Simulation: a. Start reading digits from table on row three column four---44176

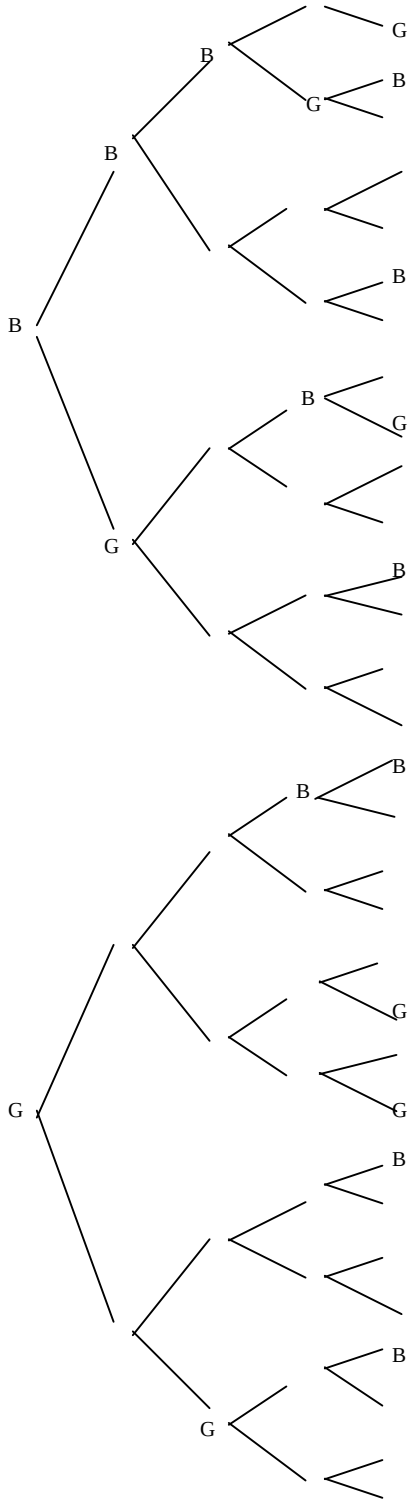
TRIAL	RESULT	3 BOYS AND 2 GIRLS?
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

b. p = _____

SIMULATION #2

Using the Random Number Table

c. Construct the tree diagram to find the theoretical probability.



P = _____

SIMULATION #2

Using the Random Number Table

Conclusions: State your conclusions in complete sentences.

_____

_____

RANDOM NUMBER TABLE

85013	81010	05520	94722	54751	94397	80273	11312	59476	73557
97831	38730	83800	60543	14636	48736	47033	44909	53102	95726
97676	89301	40643	44176	07438	22748	70318	26640	00018	65129
35454	46858	22215	15559	18946	54279	43079	88549	54321	74261
33808	77394	53672	16900	72283	69420	77584	89712	51987	65870
08818	73110	02546	72800	45870	17288	20941	00880	09507	41497
86996	47792	13423	91627	26728	22281	31489	37269	93842	51720
12235	00669	92756	07053	29520	62184	96619	96594	24286	94414
03803	79919	11684	38022	13198	32879	51408	87162	62871	77776
23832	43812	69919	77207	23136	37553	92164	08868	16340	14223
50173	29502	74381	73132	04020	57702	11826	29648	04555	22356
94743	20291	59698	77626	43134	44563	26094	80363	81505	93004
10564	36408	40529	16040	53555	21751	98507	99499	01145	04748
26116	38250	78762	80130	28123	78936	27675	37602	89478	60417
74263	65333	97032	86204	34202	46019	35942	41598	18280	35421
19358	79569	77310	97698	96740	41799	20622	03280	91432	39257
99900	62121	87653	43117	76954	26345	84095	22352	20035	90848
3599	64479	16130	22708	44230	15223	96619	60261	15404	36590
59079	15340	68215	15495	34639	45453	43673	77320	87704	86950
67597	64905	04640	43874	78429	18306	28540	69861	23540	34778

SIMULATION #3

Using the Random Number Table

Name:_____

Date:_____Period:_____

Problem: Gerrie wanted all of the **10 different toys** packaged one each in boxes sold by a candy company. On average how many boxes of candy would she have to buy to obtain all 10 toys? Do 30 trials to estimate the average. [A single trial is finished when all toys are obtained. Put a tally in the box corresponding to that toy. Continue until all boxes have at least one tally. Count the number of tallies when this has been accomplished.]

Assumptions:

Assign digits:

Simulation: a. Start reading your digits anywhere on the random table provided or use your TI-83 to randomly select digits 0 through 9. **MATH⟶PRB** 5(randINT) type (0,9,75) **Enter**. Repeat each trial by typing **2nd Enter Enter** for a new set of digits.

TRIAL	0	1	2	3	4	5	6	7	8	9	TOTAL
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
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21											
22											
23											
24											
25											
26											
27											
28											
29											
30											

SIMULATION #3

Using the Random Number Table

b. *Average* = _____

Conclusions: State your conclusions in complete sentences.

_____

_____

RANDOM NUMBER TABLE

85013	81010	05520	94722	54751	94397	80273	11312	59476	73557
97831	38730	83800	60543	14636	48736	47033	44909	53102	95726
97676	89301	40643	44176	07438	22748	70318	26640	00018	65129
35454	46858	22215	15559	18946	54279	43079	88549	54321	74261
33808	77394	53672	16900	72283	69420	77584	89712	51987	65870
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23832	43812	69919	77207	23136	37553	92164	08868	16340	14223
50173	29502	74381	73132	04020	57702	11826	29648	04555	22356
94743	20291	59698	77626	43134	44563	26094	80363	81505	93004
10564	36408	40529	16040	53555	21751	98507	99499	01145	04748
26116	38250	78762	80130	28123	78936	27675	37602	89478	60417
74263	65333	97032	86204	34202	46019	35942	41598	18280	35421
19358	79569	77310	97698	96740	41799	20622	03280	91432	39257
99900	62121	87653	43117	76954	26345	84095	22352	20035	90848
3599	64479	16130	22708	44230	15223	96619	60261	15404	36590
59079	15340	68215	15495	34639	45453	43673	77320	87704	86950
67597	64905	04640	43874	78429	18306	28540	69861	23540	34778

TEACHERS RESOURCES

Using the Random Number Table

Answers to Simulation #1:

a.

TRIAL	RESULT	2 HEADS AND 2 TAILS?
1	HTHT	YES
2	THTH	YES
3	THHT	YES
4	THHT	YES
5	HTHH	
6	THTT	
7	TTHT	
8	TTHH	YES
9	HTTT	
10	TTTH	
11	TTHT	
12	HTTT	
13	TTTT	
14	HTTT	
15	HTTH	YES
16	HTHH	
17	HHHT	
18	HTTH	YES
19	HTHH	
20	HTTH	YES
21	HTHT	YES
22	THHT	YES
23	HTTT	
24	THHT	YES
25	TTHH	YES

b. Successes = 12

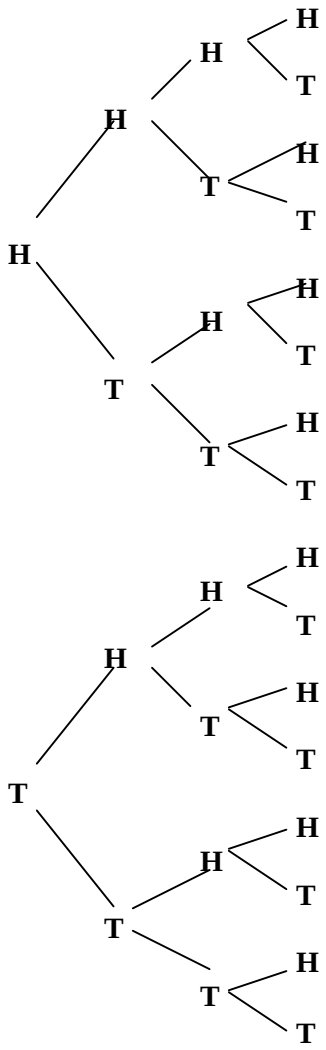
c. P = 12/25 = .48

TEACHERS RESOURCES

Using the Random Number Table

Answers to Simulation #1 (cont)

d.



P = 6/16 = 3/8 = .375

Conclusions:

Comments will vary. "Probabilities are not equal", "Simulation probability is larger." Encourage class discussion about why the probabilities are so different and what can be done to close the gap between the experimental and the theoretical probabilities. (More simulations)

TEACHERS RESOURCES

Using the Random Number Table

Answers to Simulation #2:

Assumptions: The probability of a boy or a girl is equally likely to occur on each try. Boys and girls births are independent of each other. There will be no multiple births here.

Assign digits: Boys are even digits and girls are odd digits in this key.

a.

TRIAL	RESULT	3 BOYS AND 2 GIRLS?
1	BBGGB	YES
2	BGBGB	YES
3	BBGBB	
4	GBGGB	
5	BBBBB	
6	BBBGB	
7	BGGBG	
8	GGBGB	
9	BBBGB	
10	BBBGG	YES
11	GGGGG	
12	GBGBB	YES
13	GBBGG	
14	BGBGG	
15	BBGBG	YES
16	GBGBG	
17	GBBBG	YES
18	GGBBB	YES
19	GGGGB	
20	GGBGB	
21	GBGBB	YES
22	GBBBG	YES
23	BGBBB	
24	GGGBB	
25	BGGGB	
26	GGGBG	
27	BGBGB	YES
28	BBBGB	
29	GGGGB	
30	BBGBB	

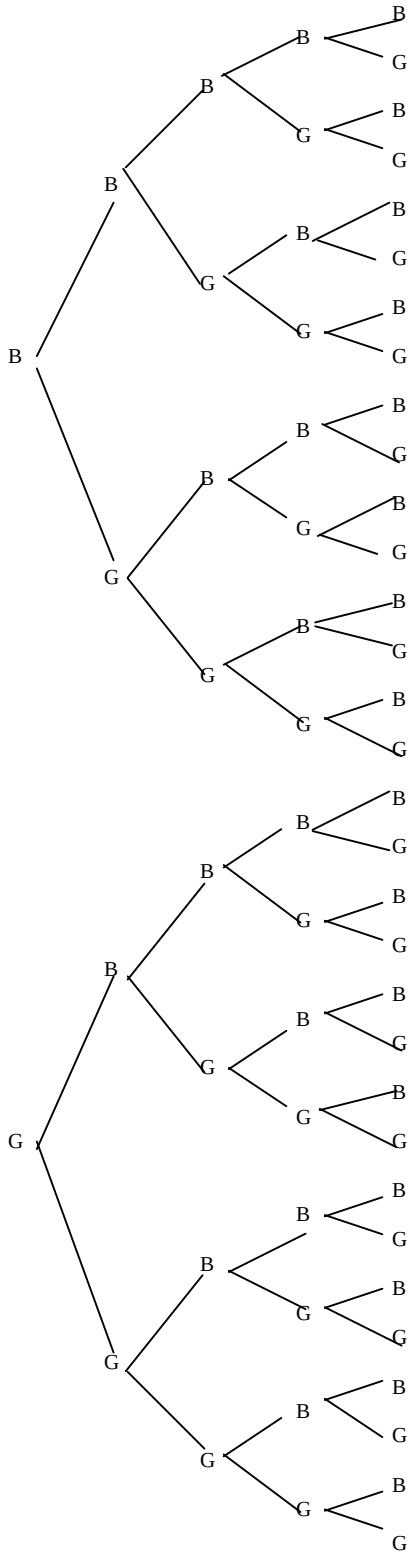
b. $p = 10/30 = 1/3 = .33$

TEACHERS RESOURCES

Using the Random Number Table

Answers to Simulation #2 (cont.)

c.


B
G
B
G
B
G

TEACHERS RESOURCES

Using the Random Number Table

Conclusions: Comments will vary again. Simulation probability is getting closer to the theoretical probability as the trials increase in number.

Answers to Simulation #3

Assumptions: Each toy is equally likely to occur in each box.
The toys are independent of each other.
The company is not "holding back" on any one toy.

Assign digits: Each digit represents a different toy.

Simulation: a. This partial key will start at **96594** (row 8 column 10).

TRIAL	0	1	2	3	4	5	6	7	8	9	TOTAL
1	||	|	||	||	||||	|	||	|	||	|||	**21**
2	|	||||	|||	|||	|	|	|	|	|||	||||	**25**
3	||	|||| |	|||| ||	|||| |	||	|	||||	|||| ||||	||||	|||	**47**
4	|||	||||	|||	|||	|||	||	|||	|	|||	|	**26**

b. Average will vary according to the starting point in the Random Number Table. Students should be averaging their results to whole numbers because they cannot buy partial boxes.

Conclusions:

The students' conclusions will vary. They will see that random numbers can repeat many times as they tally in order to find every toy. **The chart is random.**

Another activity with the numbers generated off the calculator and/or computer will be useful as a follow up. Also, the teacher may wish to place a price value on the box of candy to see on average how much one would expect to pay in order to obtain all the toys.